Machine Vision, exam 18.05.2017

You may write your answers in Finnish or English.

1. Briefly explain the following terms (6 p)
   (a) HSV color space
   (b) Radial distortion
   (c) The aperture problem
   (d) Unsupervised learning
   (e) Feature descriptor
   (f) Diffuse reflection

2. Describe the main principles of the following and give one example of their usage:
   (a) The epipolar constraint. (2 p)
   (b) Random sample consensus (RANSAC). (2 p)
   (c) Optical flow. (2 p)
   (d) Hough transform. (2 p)

3. Texture
   (a) Explain the basic principle of the LBP operator. Describe a method for automatic texture recognition based on LBP features. (2 p)
   (b) Texture recognition is one texture related task. Name and describe briefly two other texture related tasks in computer vision. (2 p)

4. 2D transformations

   A rectangle is deformed as observed in figure 1. It is known that the coordinates of the points deform through a function of the following form:

$$x' = ax + by$$
$$y' = cx^2 + dy$$

   (a) How many degrees of freedom does the transformation have? How many point correspondences are needed to estimate the parameters? (1 p)
   (b) Derive the equations to estimate the transformation parameters from a set of point correspondences. **Hint:** the transformation can be estimated linearly through a system of the form $\mathbf{Ax} = \mathbf{b}$. (2 p)

(c) Some points have been measured before and after the transformation, $\mathbf{p}$ and $\mathbf{p}'$ respectively.

$$\mathbf{p} = \begin{bmatrix} 0 & 2.00 & 4.00 & 6.00 & 8.00 & 10.00 & 10.00 & 8.00 & 6.00 & 4.00 & 2.00 & 0 \\ 1 & 1.00 & 1.00 & 1.00 & 1.00 & 1.00 & 2.00 & 2.00 & 2.00 & 2.00 & 2.00 & 2 \end{bmatrix}$$

$$\mathbf{p}' = \begin{bmatrix} 2 & 4.00 & 6.00 & 8.00 & 10.00 & 12.00 & 14.00 & 12.00 & 10.00 & 8.00 & 6.00 & 4 \\ 1 & 1.04 & 1.16 & 1.36 & 1.64 & 2.00 & 3.00 & 2.64 & 2.36 & 2.16 & 2.04 & 2 \end{bmatrix}$$

Recover the parameters a, b, c, d, while assuming that there is no noise in the measurements. How would your solution be different if there was noise? (3 p)

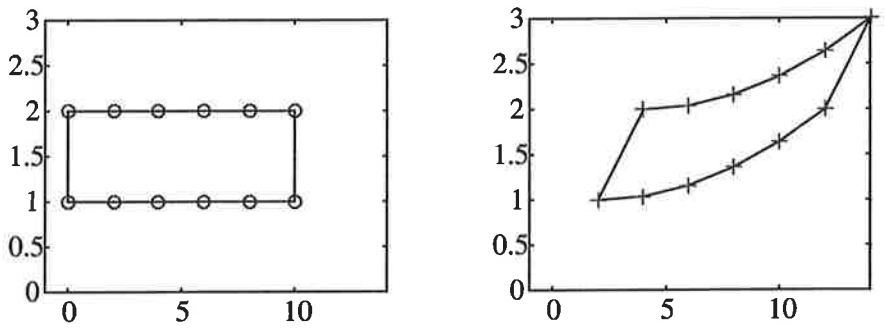

Figure 1: **Left:** rectangle before deformation. **Right:** rectangle after deformation.